

IN THE SPECIFICATION

Kindly amend pages 15-29 of the specification as follows by deleting the bracketed subject matter and inserting the underlined material:

amount of F contained in the fluoride or fluorides should be 10 - 45% in order to minimize the change in refractive index of the glass due to the compaction phenomenon. The above described oxides may be substituted by fluorides and the above described fluorides may be substituted by oxides within a range in which the ratio of metal ion, oxygen ion and fluorine ion of the respective oxides and fluorides is maintained.

Examples

Examples of the optical glass made according to the invention will now be described. Examples No. 1 to No. 24 21 shown in Tables 1 to 4 are examples of composition of the SiO_2 -PbO-alkali metal oxide glass of the present invention. Examples No. 25 22 to No. 38 34 shown in Tables 5 and 6 are examples of composition of the SiO_2 - B_2O_3 -alkali metal oxide and/or alkaline earth metal oxide glass of the present invention. Examples No. 39 35 to 59 55 shown in Tables 7 to 9 are examples of composition of the P_2O_5 - Al_2O_3 -alkaline earth metal fluoride glass of the present invention.

Table 10 shows comparison (Comparison I and Comparison II) between Examples No. 60 56 to No. 64 60 of the SiO_2 -PbO-alkali meal oxide glass of the present invention and Comparative Examples No. A and No. B of the prior art glasses.

Table 11 shows comparison (Comparison III and Comparison IV) between Examples No. 65 61 and No. 66 62 of the SiO_2 - B_2O_3 -alkali metal oxide and/or alkaline earth metal oxide glass of the present invention and Comparative Examples No. C and No. D of the prior art glasses.

In Tables 1 to 11, Δn (ppm) represents an amount of change in refractive index between a state before radiation and a state after radiation in a portion where radiation of laser beam having beam diameter of 2.0mm, wavelength of 351 nm, average output power of 0.43W, pulse repetition rate of 5kHz and pulse width of 400ns has been radiated for 1 hour..

Table 12 shows Examples No. ~~67~~ 63 to No. ~~70~~ 66 of the SiO_2 -PbO-alkali metal oxide glass of the present invention and Examples No. ~~74~~ 67 to No. ~~73~~ 71 of the SiO_2 - B_2O_3 -alkali metal oxide and/or alkaline earth metal oxide glass of the present invention. Table 13 shows change in refractive index Δn (ppm) between a state before radiation and a state after radiation in a portion where radiation of the above-mentioned laser beam (having wavelength of 351 nm and beam diameter of 2.0mm) has been made on the glasses shown in Table 12 under conditions of output and radiation time which are different from those of Tables 1 to 11.

Table 1

(mass %)

	1	2	3	4	5	6	7
SiO_2	61.390	66.000	63.000	64.800	53.200	55.880	50.200
PbO	24.800	19.890	20.200	18.500	34.600	30.200	38.200
Na_2O	9.000	6.100	6.500	9.200	6.700	6.000	5.400
K_2O	4.000	7.700	7.900	6.700	5.200	7.600	5.400
As_2O_3	0.200	0.300		0.299	0.300		0.295
Sb_2O_3			0.100			0.300	
Al_2O_3			0.400				
K_2SiF_6			1.900	0.500			
KHF_2	0.600						
TiO_2	0.010	0.010		0.001		0.020	0.005
B_2O_3							0.500
total	100.000	100.000	100.000	100.000	100.000	100.000	100.000
F	0.292		0.983	0.259			
n_d	1.5481	1.5317	1.5317	1.5317	1.5814	1.5673	1.5955
ν_d	45.8	49.0	49.0	49.0	40.8	42.8	39.3
Δn (ppm)	3.1	3.2	2.0	2.5	4.9	3.9	4.7

Table 2

(mass %)

	8	9	<u>9</u> 10	<u>10</u> 11	<u>11</u> 12	<u>12</u> 13	<u>13</u> 14
SiO ₂	49.700	45.500	53.100	53.100	53.100	51.995	40.000
PbO	38.200	44.900	34.700	32.700	29.700	34.000	44.800
Na ₂ O	10.800	4.000	5.700	6.700	6.700	6.600	5.000
K ₂ O		4.800	3.700	4.700	4.700	5.100	5.000
As ₂ O ₃	0.295	0.295	0.295	0.295	0.295		0.200
Sb ₂ O ₃						0.300	
K ₂ SiF ₆		—	0.500	0.500	0.500	2.000	
KHF ₂	1.000	0.500					
B ₂ O ₃							5.000
TiO ₂	0.005	0.005	0.005	0.005	0.005	0.005	
Li ₂ O			2.000				
CaO				2.000			
BaO					5.000		
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000
F	0.486	0.243	0.259	0.259	0.259	1.035	
n _d	1.5955	1.6200	1.5866	1.5800	1.5801	1.5717	1.6258
ν _d	38.7	36.3	40.9	40.8	40.9	41.7	36.9
Δ	4.5	4.2	4.6	4.8	3.9	4.6	4.5
n (ppm)							

Table 3

(mass %)

	15	14 16	17	15 18	19	16 20
SiO ₂	68.95	41.00	63.00	66.00	45.00	53.00
PbO	14.75	50.00	15.00	18.00	38.00	32.00
Na ₂ O	7.90	8.50	8.70	14.00		6.70
K ₂ O	5.40		6.00		15.00	6.00
As ₂ O ₃	0.30	0.30	0.30	0.20	0.30	0.30
Al ₂ O ₃	1.00		2.00			
K ₂ SiF ₆				1.80		
KHF ₂	1.20	0.20				
B ₂ O ₃	0.50		5.00		1.70	
SrO						2.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
F	0.58	0.10		0.93		
n _d	1.5094	1.6407	1.5171	1.5271	1.5998	1.5785
ν _d	55.5	34.7	54.0	50.3	38.8	41.4
Δ	2.3	4.5	3.3	2.5	4.6	4.6
n (ppm)						

Table 4

(mass %)

	<u>17</u> 21	<u>18</u> 22	<u>19</u> 23	<u>20</u> 24
SiO ₂	58.80	59.74	52.64	51.65
PbO	25.05	25.00	34.80	34.77
Na ₂ O	9.30	9.20	6.92	6.92
K ₂ O	4.80	4.70	4.34	5.35
As ₂ O ₃	0.20	0.20	0.10	0.10
Al ₂ O ₃	0.30	0.20	0.20	0.20
K ₂ SiF ₆	1.54	0.95	1.00	1.00
TiO ₂	0.01	0.01		0.01
total	100.00	100.00	100.00	100.00
F	0.80	0.49	0.52	0.52
n _d	1.5464	1.5470	1.5790	1.5781
ν _d	45.8	45.8	40.9	41.0
Δ n (ppm)	2.9	2.4	4.3	3.9

Table 5

(mass %)

	<u>21</u> 25	<u>22</u> 26	<u>23</u> 27	<u>24</u> 28	<u>25</u> 29	<u>26</u> 30	<u>27</u> 31
SiO ₂	64.950	55.850	55.350	42.000	35.550	30.000	68.990
B ₂ O ₃	14.900	13.050	6.050	13.600	16.000	20.000	11.100
Al ₂ O ₃	2.300	0.500	0.600	4.200	4.500	5.500	
Li ₂ O			3.000	2.000	2.000	2.000	
Na ₂ O	9.250		1.200	0.300	0.300		9.550
K ₂ O	6.850	11.450	8.700				7.750
BaO			16.850	37.050	40.750	40.000	1.550
ZnO			5.750				1.000
PbO	1.095		2.000		0.500		
TiO ₂	0.005	0.050		0.100			0.010
As ₂ O ₃	0.150		0.250	0.400	0.400	0.300	
Sb ₂ O ₃		0.010	0.250				0.050
K ₂ SiF ₆		19.090					
KHF ₂	0.500			0.350		0.200	
CaO						2.000	
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000
F	0.243	9.879		0.170		0.097	
Nd	1.5163	1.4875	1.5567	1.5891	1.6031	1.6056	1.5163
Nd	64.1	70.2	58.7	61.2	60.6	61.1	64.1
Δ n (ppm)	0.7	0.0	0.5	0.5	0.7	0.3	0.0

Table 6

(mass 5)

	<u>28</u> 32	<u>29</u> 33	<u>30</u> 34	<u>31</u> 35	<u>32</u> 36	<u>33</u> 37	<u>34</u> 38
SiO ₂	67.20	67.80	40.00	34.55	49.00	55.80	35.50
B ₂ O ₃	3.60	4.10	12.30	18.00	17.90	13.05	16.00
Al ₂ O ₃			4.50	5.50	0.30	0.50	4.50
Li ₂ O			2.00				2.00
Na ₂ O	12.50	12.10	0.30	0.30			0.50
K ₂ O	6.13	6.15			12.00	11.40	0.20
BaO	10.22	9.45	38.00	38.75			40.80
PbO				0.50			
TiO ₂		0.20	0.50			0.04	0.10
As ₂ O ₃	0.35		0.40	0.40	0.20	0.01	0.40
Sb ₂ O ₃		0.20					
K ₂ SiF ₆						19.20	
KHF ₂					20.60		
SrO			2.00				
ZrO ₂				2.00			
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F					10.02	9.94	
Nd	1.5184	1.5184	1.5962	1.5989	1.4850	1.4860	1.6025
Nd	60.3	60.3	60.5	60.3	70.1	69.7	60.5
Δ n (ppm)	0.4	0.2	0.4	0.3	0.1	0.1	0.5

Table 7

(mass %)

	<u>35</u> 39	<u>36</u> 40	<u>37</u> 41	<u>38</u> 42	<u>39</u> 43	<u>40</u> 44	<u>41</u> 45	<u>42</u> 46
P ₂ O ₅	27.45	22.45	21.05	5.55	10.85	9.35	19.40	4.85
Al ₂ O ₃	6.55	5.35	5.05	1.35	2.60	2.20	3.95	1.15
AlF ₃	7.25	11.55	12.45	24.30	24.05	28.30		27.20
MgF ₂	4.45	6.05	5.10	5.20	4.25	5.30		4.05
CaF ₂	11.20	15.80	16.05	25.55	20.95	16.65		20.20
SrF ₂	18.00	20.35	25.85	26.10	24.00	26.75	22.00	21.55
BaF ₂	25.10	18.45	14.45	11.80	13.20	10.65	44.50	15.00
YF ₃								5.00
NaF					0.10			
KF				0.15				1.00
Y ₂ O ₃							3.00	
La ₂ O ₃							5.00	
SnO ₂							0.05	
SrO						0.80	2.10	
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	23.97	29.37	30.32	42.60	39.28	40.94	16.30	42.94
Nd	1.5296	1.5043	1.5006	1.4353	1.4505	1.4541	1.5632	1.4388
Nd	76.2	79.4	81.1	85.5	81.6	90.5	69.8	95.1
Δ n (ppm)	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0

Table 8

(mass %)

	43 47	44 48	45 49	46 50	47 51	48 52	49 53	50 54
P ₂ O ₅	25.00	38.20	22.60	20.00	32.15	21.50	11.70	20.15
Al ₂ O ₃	6.00	8.60	5.40		1.80	3.30	2.80	2.55
AlF ₃				10.00	7.50		26.50	13.75
MgF ₂			0.50		2.35	8.00	4.00	4.90
CaF ₂		9.00		10.00	7.00	15.00	14.00	15.40
SrF ₂	15.00		14.00	20.00	9.20	13.00	23.00	15.85
BaF ₂	28.00	22.00	47.00	20.00	25.00	22.00	12.00	15.80
YF ₃		3.00						
LaF ₃	5.00		2.00					
GdF ₃						10.00		2.60
LiF			2.50					
Y ₂ O ₃	10.00	5.50	6.00					
La ₂ O ₃	10.00	6.20						
Gd ₂ O ₃		5.00		20.00		5.00		
SnO ₂	1.00							
MgO					5.00	2.20		
CaO							6.00	
SrO								9.00
BaO		2.40			10.00			
As ₂ O ₃		0.10						
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	12.06	16.83	17.14	22.04	22.21	23.54	36.80	28.73
Nd	1.5826	1.5913	1.5583	1.5783	1.5532	1.5022	1.4565	1.4973
Nd	70.3	72.6	70.6	72.0	71.2	79.2	90.1	80.9
Δ	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.2
n (ppm)								

Table 9

(mass %)

	<u>51</u> <u>55</u>	<u>52</u> <u>56</u>	<u>53</u> <u>57</u>	<u>54</u> <u>58</u>	<u>55</u> <u>59</u>
P ₂ O ₅	4.00	25.00	25.00	11.70	24.00
Al ₂ O ₃	1.00	7.00	6.00	2.80	6.00
AlF ₃	27.00			25.50	
MgF ₂	5.00			4.50	2.00
CaF ₂	21.00		5.00	13.50	2.00
SrF ₂	21.00	15.00	15.00	22.50	13.00
BaF ₂	16.00	19.00	23.00	12.50	27.00
YF ₃	5.00	10.00			
LaF ₃		5.00	10.00		5.00
NaF				1.00	
Y ₂ O ₃			10.00		5.00
La ₂ O ₃		10.00			5.00
Gd ₂ O ₃			5.00		
Yb ₂ O ₃					10.00
CaO				6.00	
SrO			1.00		
BaO		9.00			1.00
Total	100.00	100.00	100.00	100.00	100.00
F	37.52	29.12	14.87	36.59	13.13
Nd	1.4378	1.5816	1.5822	1.4562	1.5820
Nd	97.1	70.2	69.9	90.0	70.1
Δ	0.1	0.1	0.2	0.1	0.1
n (ppm)					

Table 10

(mass %)

	Comparison I			Comparison II			
	56 60	57 61	Com. Ex. A	58 62	59 63	60 64	Com. Ex. B
SiO ₂	63.00	65.30	66.00	53.10	53.05	52.00	53.10
PbO	20.20	18.50	19.90	34.70	34.70	34.00	34.70
Na ₂ O	6.50	9.20	6.10	6.70	6.70	6.60	6.70
K ₂ O	7.90	6.70	7.70	5.20	5.20	5.10	5.20
As ₂ O ₃		0.30		0.30		0.30	
Sb ₂ O ₃	0.10		0.30		0.30		0.30
Al ₂ O ₃	0.40						
K ₂ SiF ₆	1.90					2.00	
TiO ₂					0.05		
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	0.98					1.04	
Nd	1.5317	1.5317	1.5317	1.5786	1.5801	1.5717	1.5800
ν d	49.0	49.0	49.0	41.0	40.9	41.7	40.8
Δ n (ppm)	2.9	3.4	6.3	4.9	4.5	4.2	10.0

Table 11

(mass %)

	Comparison III			Comparison IV		
	61	65	Com. Ex. C	62	66	Com. Ex. D
SiO ₂	67.80		67.20	68.99		64.95
B ₂ O ₃	4.10		3.60	11.10		14.90
Al ₂ O ₃						2.30
Na ₂ O	12.10		12.50	9.55		9.25
K ₂ O	6.15		6.13	7.75		6.85
BaO	9.45		10.22	1.55		
ZnO				1.00		
PbO						1.60
TiO ₂	0.20			0.01		
Sb ₂ O ₃	0.20		0.35	0.05		0.15
Total	100.00		100.00	100.00		100.00
Nd	1.5184		1.5184	1.5163		1.5163
ν d	60.3		60.3	64.1		64.1
Δ n (ppm)	0.2		6.0	0.0		7.0

Table 12

(mass%)

No.	<u>63</u> <u>67</u>	<u>64</u> <u>68</u>	<u>65</u> <u>69</u>	<u>66</u> <u>70</u>	<u>67</u> <u>71</u>	<u>68</u> <u>72</u>	<u>69</u> <u>73</u>
SiO ₂	63.20	65.48	51.62	51.62	57.85	68.50	69.34
B ₂ O ₃					13.52	3.99	11.11
PbO	20.33	20.27	34.80	34.80			
K ₂ O	7.96	7.79	5.35	5.35	11.85	6.00	7.76
Na ₂ O	6.51	6.18	6.93	6.92		11.85	9.55
Al ₂ O	0.37		0.20	0.20	0.50		
K ₂ SiF ₆	1.53		1.00	1.00	16.23		
As ₂ O ₃		0.28	0.10	0.10	0.01	0.20	0.03
Sb ₂ O ₃	0.10						
TiO ₂				0.01	0.04	0.20	0.01
BaO						9.26	1.19
ZnO							1.01
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
F	0.79		0.52	0.52	8.40		
nd	1.53168	1.53145	1.57904	1.57807	1.48713	1.51820	1.51593
ν d	48.9	49.0	40.9	41.0	70.2	60.3	64.1

Table 13

		(mass%) Δn (ppm)											
No.		<u>63</u> <u>67</u>	<u>64</u> <u>68</u>	<u>65</u> <u>69</u>	<u>66</u> <u>70</u>	<u>67</u> <u>71</u>	<u>68</u> <u>72</u>	<u>69</u> <u>73</u>					
Average Output Power(W)	Time												
0.10	165hrs	0.2											
0.60	10min.	0.3											
0.60	15min.	0.3											
0.60	30min.	0.5											
0.60	1hour	0.5											
0.60	10min.		0.6										
0.60	1hour		1.1										
2.00	10min.			0.7									
1.20	15min.			1.0									
2.00	25min.			1.6									
2.00	10min.				0.5								
1.20	15min.				0.8								
2.00	25min.				1.3								
1.50	3hrs					0.0							
2.65	3hrs.						0.5						
2.65	3hrs.							0.6					

As shown in Tables 1 to 12, the amount of change Δn in a period between before and after radiation of laser beam in the glasses of Examples No. 1 to No. 73 ~~69~~ is 5 ppm or below. The glasses of Examples No. ~~60~~ 56 - No. ~~66~~ 62 shown in Tables 10 and 11 all have a smaller amount of change (Δn) in a period between before and after radiation of laser beam than the prior art glasses of Comparative Examples No. A to No. D which have similar contents of SiO₂, PbO, B₂O₃, alkali metal oxide and BaO as well as similar values of n_d and ν_d to these Examples of the invention and, thus, show the advantageous effects of containing the fluorine ingredient and/or the titanium oxide ingredient and/or the arsenic oxide ingredient.

The glasses of the above described examples of the invention can be easily manufactured by weighing and mixing optical glass materials such as oxides, carbonates, nitrates, hydroxides, phosphates and fluorides, melting the materials at 900 - 1500°C for about 3 hours to 10 hours in a platinum container and/or a quartz container and thereafter refining, stirring, and homogenizing the melt and cooling the melt to a predetermined temperature, and casting it in a preheated mold and annealing it.

In summing up, the optical glass of the present invention is an optical glass wherein an amount of change in refractive index (Δn : difference in refractive index between a state before radiation and a state after radiation) caused by radiation of laser beam at wavelength of 351nm having average output power of 0.43W, pulse repetition rate of 5kHz and pulse width of 400ns for one hour is 5 ppm or below..

It is also an optical glass comprising a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient. It is also a SiO₂-PbO-alkali metal oxide glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range, or a SiO₂-B₂O₃-alkali metal oxide and/or alkaline earth metal oxide glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range, or a P₂O₅-Al₂O₃-alkaline earth metal fluoride glass containing a fluorine ingredient and/or a titanium oxide ingredient and/or an arsenic oxide ingredient respectively of a specific composition range. In the optical glasses of the present